can be also terminated in a variety of conventional mechanical terminations that are typically used in conventional wire rope making art.

Referring to FIGS. **9–11**, another embodiment of a four bar linkage **252** driven by a SMA actuator **268** includes an output arm **254**, with the SMA actuator **268** secured thereto, and a fixed arm **262**. The four bar linkage **252** also includes a flap **238** and a link **260** connecting the output arm **254** and the fixed arm **262** by means of pivots **256**, **264**, respectively. The SMA actuator **268** has a first end **278** and a second end **280**, as best seen in FIG. **11**, and includes a plurality of SMA units **272** that can be formed from either SMA strands or SMA ropes, as discussed above and shown in FIG. **5**. The first and second ends **278**, **280** of the SMA actuator **268** are fixed, as shown in FIG. **11**. The four bar linkage **252** is configured to translate a sweeping motion of the SMA actuator **268** in a non-parallel fashion. The four bar linkage **252**, according to this embodiment of the present invention, can be used with complex geometry of the variable area nozzle or with any other mechanism that requires non-parallel motion.

The major benefit of the variable area nozzle **30**, **130** and of the four bar linkage **52**, **152**, **252** driven by SMA actuators of the present invention is that they are actively controlled and used in multi-cycle applications to generate significant force output. One major advantage of these mechanisms is relative simplicity and compactness.

Another major advantage of the variable area nozzle **30**, **130** of the present invention is that a gas turbine engine can be equipped with a variable area nozzle without incurring a significant weight penalty. The variable area nozzles **30**, **130** of the present invention, driven by a SMA actuator, are substantially lighter than existing variable area nozzle configurations. The variable area nozzle **130** having a return mechanism **142** actuated by the secondary SMA actuator **143** is more advantageous and results in even greater weight savings. This advantage of the present invention allows practical use of the variable area nozzle on the gas turbine engines.

A further major advantage of the present invention is that the variable area nozzles, driven by at least one SMA actuator, do not require extensive maintenance. Unlike existing variable area nozzles that include complex mechanisms and are driven either hydraulically or pneumatically, the variable area nozzles **30**, **130** of the present invention do not include a complex mechanism requiring expensive and time consuming maintenance.

A further advantage of the present invention is that the SMA actuator **68**, configured from a plurality of strands **70** formed from a plurality of SMA wires **74**, will not fail catastrophically under normal fatigue or overload situations. Since the SMA actuator **68** includes multiple smaller diameter wires, when one or more wires fail, such failure will be apparent during visual, electrical or other type of nondestructive inspection. Thus, when failure in one or several wires is detected, repair or replacement can be scheduled to avoid subsequent catastrophic failure.

While the present invention has been illustrated and described with respect to a particular embodiment thereof, it should be appreciated by those of ordinary skill in the art, that various modifications to this invention may be made without departing from the spirit and scope of the present invention. For example, although the preferred embodiment describes the SMA actuator **68** formed into an array of SMA strands, the SMA actuator **68** can be formed from a SMA rod or tube. Furthermore, the SMA actuator **68** can be formed from a plurality of individual SMA wires that are bundled together in various configurations of strands or ropes. Additionally, the SMA wires **74** can have a round cross-section or other shapes of cross-section. Moreover, although the SMA actuator **68** and the primary SMA actuator **168** are heated to close or deploy the flaps **38** of the variable area nozzle, the SMA actuator **68** and the primary SMA actuator **168** can be heated to open or place the flaps in the diverged position. Also, the parent shape of the SMA can be either contracted or expanded. Furthermore, the SMA actuators **68**, **168** may include multiple terminations and multiple power sources. For example, the SMA actuators **68**, **168** can be segmented with each SMA actuator segment spanning a half, a quarter or any other portion of the engine's circumference.

Additionally, various other return mechanisms can be used to deform the SMA actuator. Also, although the preferred embodiment of the present invention is described as having a return mechanism **42** and an actuating mechanism **40** corresponding to each flap **38**, each return mechanism **42** and each actuating mechanism **40** can drive more than one flap **38**. Furthermore, various other configurations of four bar linkages **52**, **152**, **252** are within the scope of the present invention.

We claim:

1. A gas turbine engine situated about a center axis and enclosed in a nacelle, said nacelle having a trailing end in a downstream portion thereof, said trailing end defining a fan exit nozzle area, said gas turbine engine comprising:

a plurality of flaps each of said flaps having an aerodynamically shaped body having a flap tip coinciding with said trailing end of said nacelle;

a plurality of actuating mechanisms for driving said plurality of flaps into an open position and a closed position corresponding to an enlarged fan exit nozzle area and a reduced fan exit nozzle area, each of said actuating mechanisms being driven by a SMA actuator, said SMA actuator being alternatingly deformed in its martensitic state and heated to its austenitic state to actuate said plurality of actuating mechanisms; and

a plurality of return mechanisms associated with said plurality of actuating mechanisms for deforming said SMA actuator in its martensitic state.

2. The gas turbine engine according to claim **1** wherein each said actuating mechanism comprises:

a four bar linkage having an output arm and a fixed arm pivotably connecting to a first link and a second link for translating a substantially parallel motion, said output arm being engaged by said SMA actuator for actuating said actuating mechanism to drive said flap.

3. The gas turbine engine according to claim **2** wherein said return mechanism comprises a secondary SMA actuator with said secondary SMA actuator engaging said four bar linkage to deform said SMA actuator of said actuating mechanism.

4. The gas turbine engine according to claim **1** wherein each said actuating mechanism comprises:

a four bar linkage having an output arm and a fixed arm pivotably connecting to a first link and a second link for translating a substantially nonparallel motion, said output arm being engaged by said SMA actuator for actuating said actuating mechanism to drive said flap.

5. The gas turbine engine according to claim **1** wherein said return mechanism comprises a spring for deforming said SMA actuator.

6. The gas turbine engine according to claim **1** wherein said return mechanism comprises a secondary SMA actuator.